

AMENDMENTS TO THE SPECIFICATION

On page 7, please amend the top paragraph, lines 1-7, as follows:

Q1 ~~bandgap ramp~~ will not be applicable in cases where diamond is ~~ehosed~~ chosen as the semiconductor. The external applied electric field set up to penetrate the target can achieve a similar result. The field penetration is applicable with all semiconductors and will exhibit various degrees of effectiveness depending on doping concentrations and other well-known characteristics of the semiconductor chosen.

On page 14, please amend the bottom paragraph, lines 24-33, as follows:

Q2 ~~We now refer to Fig. 2, which better illustrates the details of target 46 and the necessary conditions for bombardment by seed electrons 18 of beam 16 to obtain high brightness and low energy spread beam 64. The distance between illumination surface 44 and emission surface 4856 defines a target thickness t. Since electrode 40 is transparent to seed electrons 18 and no appreciable generation of electron-hole pairs occurs in electrode 40, thickness t does not take into account electrode 40. For example, electrode 40 is a thin Al coating or gold layer which is crack free.~~

On page 15, please amend the bottom paragraph, lines 27-34, as follows:

Q3 ~~A fraction of electron-hole pairs 72 supply emission electrons 12 at emission surface 4856. In particular, as shown in the energy diagram on the example of one electron 68, thickness t of target 46 is selected in coordination with the energy of seed electrons 18 and taking into account the electron-hole recombination rate. Specifically, target thickness t is selected such that by the time electron 68~~

Q3 reaches emission surface 4856 it is substantially thermalized but has still not

On page 16, please amend the entire page, lines 1-34, as follows:

Q4 —had sufficient time to recombine with hole 70. In other words, by the time electron 68 reaches emission surface 4856 it is contained in the lowermost (hatched) portion of conduction band 74 but has not had sufficient time to drop back into valence band 76 due to electron-hole recombination. Thermalization is a process by which the energy of electron 68 is reduced through phonon interactions and other interactions with the lattice of semiconductor 52. At room-temperature substantially thermalized electron 68 exhibit an energy spread of about 0.026 eV and even less at lower temperatures. There are other contributions to this energy spread, however, depending on specific conditions as is known in the art. Reported energy spreads are as low as .5 eV but less than .1 eV can also be achieved. For the purposes of this application substantially thermalized electron 68 exhibits ~~and an~~ energy spread of about 1 eV or less and preferably about 0.1 eV or even less.

A certain fraction of electrons 68 from electron-hole pairs 72 become thermalized, as described above, and are drawn off emission surface 4856 by electric field E_2 . Because of NEA of semiconductor 52 at emission surface 56 thanks to hydrogen-termination or Cs and O coating 54, energy bands 74 and 76 are bent near emission surface such that the lowermost portion of conduction band 74 drops below the vacuum energy level (not shown). In other words, there is no energy barrier at emission surface 56 to the emission of emission electrons 12. This

Q4 condition enables electric field E_2 to easily draw off emission electrons 12 from emission surface 4856. Because emission electrons 12 are drawn from the available pool of substantially thermalized electrons 68, they exhibit an energy spread which is usually degraded by the Boerch effect. This effect causes the electron energy spread to become somewhat worse in beam 64. A person skilled in the art will know that—

On page 17, please amend the entire page, lines 1-34, as follows:

~~This~~ this effect can be mitigated if emission electrons 12 are accelerated very quickly by external applied electric field E_2 .

Q5 Emission electrons 12 drawn off emission surface 4856 produce beam 64 exhibiting a high brightness or current per unit solid angle. Referring back to Fig. 1, emission electrons 12 are drawn off and exhibit a solid angle schematically indicated by α in Fig. 1. The angular distribution is typically Lambertian, or $\cos \alpha$. The emission electrons 12 exhibit a brightness at 10 keV applied field E_2 of better than 10^5 A/cm²/sterdian. In conjunction with the robustness of target 46 and an energy spread of less than 1 eV and preferably less than .1 eV this renders semiconductor source 10 an excellent electron beam source for high resolution SEM, display applications, as well as lithography, low-noise amplification, metrological applications and many others. Source 10 is easy to use, efficient and low-cost and robust.

In optimizing the energy of seed electrons 18 and thickness t of target 46, it is useful to determine the penetration depth of seed electrons 18 inside target 46. The energy of seed electrons 18 is then preferably selected such that seed electrons 18 do not fully penetrate target 46. At the same

65 time, the energy spread of emission electrons 12 can be monitored as a function of thickness t (e.g., by using a wedge-shaped target 46). Fig. 3 illustrates a typical energy spread decrease as thickness t is increased. The dashed graph indicates the energy of emission electrons 12 observed at a first thickness t_1 and the solid graph indicates the energy of emission electrons 12 at a larger thickness t_2 . Both thicknesses t_1 , t_2 are selected to completely prevent the penetration of target 4446 by seed electrons 18. Clearly, at thickness t_2 the energy spread B is smaller than the energy spread A at thickness t_1 . Therefore, thickness t_2 is selected.